Diamondback Terrapin Paired Crab Trap Study in the Mission-Aransas Estuary, Texas

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Executive Summary

It is widely accepted that diamondback terrapin populations are declining throughout the species' range. While many factors contribute to these declines, researchers agree that crab trap bycatch mortality represents the most prominent threat to diamondback terrapins. The effectiveness of bycatch reduction devices (BRDs) at excluding terrapins is well documented outside of Texas. Research has also shown that BRDs have no negative impacts on blue crab catch in terms of both size and number. The objective of this study was to test the effectiveness of BRDs in excluding terrapins from crab traps without restricting ingress of blue crabs, in a Texas estuary.

The study was performed in the Mission-Aransas Estuary, Texas from July 2013 through November 2013 and March 2014 through June 2014. Twenty four crab traps (12 experimental, 12 control) were used to capture Texas diamondback terrapins and blue crabs for three consecutive days each month that sampling occurred. Catch rates for Texas diamondback terrapins and blue crabs were compared between the two trap types.

Two diamondback terrapins were captured in control traps, whereas none were caught in traps equipped with BRDs. Blue crabs were divided into four groups for analysis: all blue crabs, blue crabs that were < 127 mm (< 5 in.), blue crabs ≥ 127 mm (≥ 5 in.), and blue crabs ≥ 152 mm (≥ 6 in.). Overall, control traps (n = 215) captured the same number of blue crabs as experimental traps (n = 215). When sublegal crabs were excluded from the analysis, the control traps (n = 150) captured slightly fewer blue crabs than experimental traps (n = 157). A Mann Whitney U test was used to compare mean carapace widths between traps types for all blue crab groups. No significant difference was found for any group. Overall bycatch was lower in experimental traps when compared to controls.

Results of this study suggest that there are no economic or environmental disadvantages to using BRDs on crab traps in Texas. Bycatch reduction devices represent an inexpensive, effective management tool for reducing diamondback terrapin bycatch mortality in Texas without negatively impacting the state's commercial blue crab fishery.

Introduction

The diamondback terrapin (*Malaclemys terrapin*) is the only brackish water turtle species in North America. Ranging from Cape Cod, MA to Corpus Christi, TX, diamondback terrapins inhabit brackish, coastal habitats including marshes, tidal creeks and rivers, and embayments. The Texas diamondback terrapin (*Malaclemys terrapin littoralis*), one of seven subspecies, is found from eastern Louisiana to Corpus Christi, TX (Pritchard 1979). Little is known regarding diamondback terrapins in Texas as research has been limited. Currently, the body of knowledge for this species in Texas consists of graduate theses and technical reports, with no peer-reviewed data to this point. In order to properly manage this species in Texas, it is imperative that more research be conducted regarding terrapins at the individual and population level. Without baseline demographic data along with identifying threats to populations, it will not be possible to ensure the long-term survival of this species in Texas estuaries.

Once considered a culinary delicacy, historical declines in terrapin populations are attributed to commercial overharvest (Bishop 1983). Highly esteemed for its flavor, commercial harvests of terrapins began in the late 1800's and continued through the 1920's, at which point the fishery collapsed and terrapins were considered commercially extinct. Prohibition has also been credited for reducing the demand for terrapins, as many of the liquors used in terrapin dishes became unavailable (Hart and Lee 2007). Although some states still allow for the commercial harvest of terrapins, its demand as a food item has decreased dramatically. As a result, terrapin populations began to slowly rebound throughout their range.

While commercial harvest no longer presents a major threat to terrapin populations, recent declines have been attributed to three main factors: (1) habitat loss/fragmentation (Roosenburg 1990), (2) vehicular traffic mortality (Szerlag and McRobert 2006) and (3) drowning in crab traps (Butler and Heinrich 2007). Incidental terrapin bycatch mortality in crab traps is well documented in New Jersey (Wood 1997), Delaware (Cole and Helser 2001), Maryland (Roosenburg and Green 2000), South Carolina (Hoyle and Gibbons 2000), Florida (Butler 2000), Alabama (Marion 1986), Mississippi (Mann 1995), and Louisiana (Guillory and Prejean 1998).

There is a consensus among researchers that crab trap bycatch mortality presents the greatest threat to diamondback terrapin populations throughout their range (Butler and Heinrich 2007; Butler et al. 2006; Seigel and Gibbons 1995). Terrapins often share habitats with blue crabs which are harvested both commercially and recreationally. Diamondback terrapins often enter traps in search of food or out of curiosity. Once inside the submerged trap, terrapins are unable to surface for breath and ultimately drown.

Bycatch reduction devices (BRDs) have been developed and tested (Wood 1997) in hopes of reducing terrapin bycatch mortality in crab traps, while maintaining typical catch rates for blue crabs (*Callinectes sapidus*). The BRDs fit inside the existing entrance funnels of the crab trap and do not require any additional modifications to traditional crab fishing gear. Bycatch reduction devices were originally constructed of heavy gauge wire, but are presently available as prefabricated plastic units. Research outside of Texas indicates that BRDs effectively exclude diamondback terrapins without impacting blue crab catch rates (Guillory and Prejean 1998; Cuevas et al. 2000; Roosenburg and Green 2000; Butler and Heinrich 2007; Rook et al. 2010; Morris et al. 2011). The commercial blue crab fishery represents a substantial industry in Texas and efforts to conserve terrapins must account for this. In 2012, the reported commercial landings for blue crab in Texas totaled 2,849,751 lbs.

valued at $2,875,688 (Texas Parks and Wildlife Department 2012). This project aimed to test BRD effectiveness in the Mission-Aransas Estuary, Texas.

Methods

Study area

The Mission-Aransas Estuary sits on the lower Gulf coast of Texas and consists of a primary bay, Aransas Bay, two secondary bays, Copano Bay and St. Charles Bay, and two tertiary bays, Mission Bay and Port Bay (Fig. 1). The Mission River, Aransas River, and Copano Creek serve as freshwater sources for the estuary. In this study, sampling occurred in Copano Bay and in the Aransas River. Copano Bay covers 112 km^2 and averages 1.5 m deep. There is little submerged vegetation on the bay bottom, although the margins of the bay are lined with emergent marsh vegetation. Oyster reefs dominate the bay bottom in Copano Bay (Mott and Lehman 2005). Commercial fishing is common in Copano Bay and fishing for oysters, blue crabs, and black drum occurs there. Copano Bay also supports previously documented populations of diamondback terrapins (Koza 2006). The Aransas River begins in south central Bee County and flows for forty miles until it empties into the southwest corner of Copano Bay (Handbook of Texas Online 2010). There is a strong tidal influence for several miles up the Aransas River, and the land use for the tidal portion is primarily agriculture and livestock.

Figure 1. The Mission-Aransas Estuary, Texas (Google Earth, 2011).

Sampling Methods

Sampling for this project occurred July 2013 through November 2013 and March 2014 through June 2014. A YSI multiparameter sonde was used to record water temperature (°C) and salinity (PSU) during all sampling events. Diamondback terrapins and blue crabs were captured using crab traps modified with chimneys to provide a permanent air space to prevent drowning of captured terrapins (Fig. 2).

Figure 2. Crab trap modified to provide a permanent air space.

Locations for the first seven sampling events were selected based on known terrapin populations reported by Koza (2006). The final two sampling events were conducted in the Aransas River, an area where terrapins had not been previously documented. Commercial crab traps were present at all selected sampling locations. During each sampling event, 24 crab traps were deployed at depths ranging from 0.6 m - 0.9 m and were baited with dead finfish. Twelve experimental traps were equipped with 4.5 cm x 12 cm BRDs (Fig. 3). The remaining twelve traps were fished without BRDs and served as control traps. Experimental and control traps were set in an alternating fashion within the study area to reduce bias. Care was taken to mimic commercial crabbing behavior as traps were set in areas fished commercially for blue crab using bait common to commercial crabbing operations.

Sampling occurred for three consecutive days a month and traps were checked and re-baited daily during that time. Captured terrapins were measured (carapace length, carapace width, shell height, plastron length, plastron width), weighed, sexed, and released at the site of capture. Blue crabs were measured (carapace width) and sexed. Crabs of legal size (≥127 mm) were removed from the study area while sublegal crabs were released at the site of capture. Finfish and other crab species captured in traps were also recorded.

Figure 3. Crab trap fitted with four bycatch reduction devices (BRDs).

Statistical Analysis

Blue crab data were grouped based on Texas crab fishing regulations and marketability. The following groups were used in statistical analysis: all blue crabs, blue crabs < 127 mm (<5 in.), blue crabs ≥ 127 mm (≥5 in.), and blue crabs ≥ 152 mm (≥6 in.). Blue crabs ≥ 127 mm are considered legal and blue crabs ≥ 152 mm are most valuable, bringing higher market prices. Overall captures (n) for all blue crab groups and diamondback terrapins were compared for experimental and control traps. Differences in mean carapace width for captured blue crab between experimental and control traps were analyzed using the Mann-Whitney U test in SPSS Statistics 19. This is a non-parametric test for comparing means between non-normal datasets with unequal variances. The test was performed for all blue crabs, blue crabs < 127 mm, blue crabs ≥ 127 mm, and blue crabs ≥ 152 mm. A catch per unit effort (CPUE = organisms captured/day) was calculated for control and experimental traps for diamondback terrapins and all blue crab groups. The significance criterion was CI = 95%, $p < 0.05$ for all test results.

Outreach

An outreach component was also included in this project to engage commercial crab fishermen in discussion regarding the use of BRDs on crab traps. An informational packet was mailed to each licensed crab fisherman in Texas and included literature pertaining to terrapin bycatch and a set of 4 BRDs (Appendix C). Also, five blue crab fishery enhancement meetings, hosted by Texas Parks and Wildlife Department (TPWD), were held to discuss potential changes in the Texas blue crab fishery. One of the topics discussed was the potential required use of BRDs on crab traps in Texas.

Results

Over the course of the study, water temperature and salinity ranged from 17.10 °C to 29.95 °C and from 3.80 PSU to 43.08 PSU, respectively. Two Texas diamondback terrapins were captured in this study (Table 1). Both of these individuals were captured in control traps. No diamondback terrapins were captured in experimental traps in this study. Diamondback terrapin CPUE is recorded in Table 1.

Table 1. Number and CPUE for Texas diamondback terrapins (*Malaclemys terrapin littoralis*) and number, mean carapace width, and CPUE for blue crabs (*Callinectes sapidus*) in experimental and control traps.

	Control	Experimental
M. terrapin littoralis (n)	2	0
CPUE *M. terrapin littoralis* (terrapins/day)	0.11	0
C. sapidus (n)	215	215
C. sapidus < 127 mm (n)	65	58
C. sapidus ≥ 127 mm (n)	150	157
C. sapidus ≥ 152 mm (n)	42	51
Mean carapace width *C. sapidus* (mm)	137.14	138.87
Mean carapace width *C. sapidus* <127 mm (mm)	114.58	115.90
Mean carapace width *C. sapidus* ≥127 mm (mm)	146.91	147.35
Mean carapace width *C. sapidus* ≥152 mm (mm)	169.61	170.65
CPUE *C. sapidus*(crabs/day)	11.94	11.94
CPUE *C. sapidus* < 127 mm (crabs/day)	3.61	3.22
CPUE *C. sapidus* ≥ 127 mm (crabs/day)	8.33	8.72
CPUE *C. sapidus* ≥ 152 mm (crabs/day)	2.33	2.83

Overall, the number of blue craps captured by trap type was equal (Table 1). Control traps captured more sublegal crabs than experimental. For blue crabs ≥ 127 mm and ≥ 152 mm, experimental traps captured slightly more blue crabs than control traps. Blue crab CPUE is recorded in Table 1. Results of the Mann-Whitney U test showed no significant difference in mean carapace width between trap types for all blue crab groups: for all blue crabs (p = .505), for blue crabs < 127 mm (p = .223), for blue crabs ≥ 127 mm (p = .863), and for blue crabs ≥ 152 mm (p = .514). Monthly blue crab captures are shown in Figures 4, 5, 6, and 7 for all blue crabs, blue crabs < 127 mm, blue crabs ≥ 127 mm and, blue crabs ≥ 152 mm, respectively. A complete list of species captured during this study is provided in Table 2.

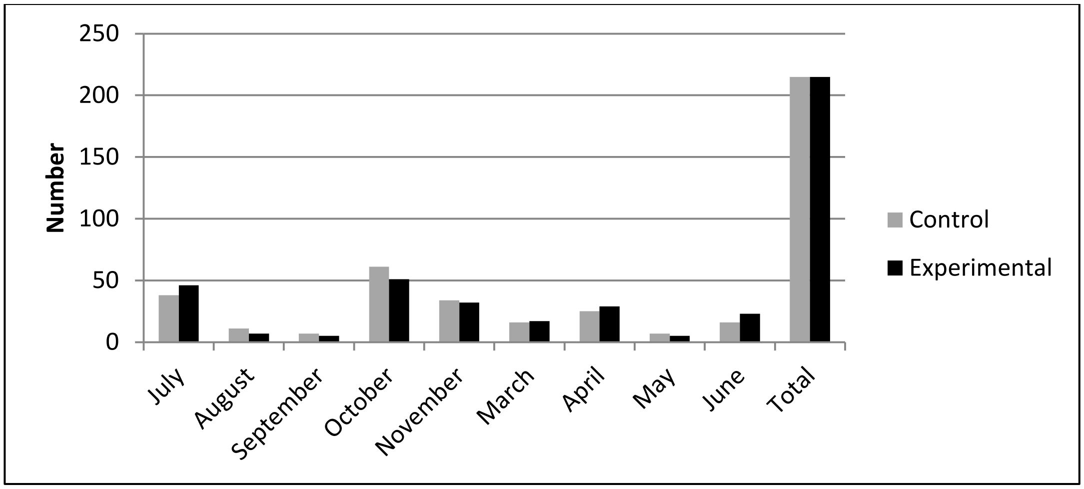

Figure 4. Monthly captures for all blue crabs in experimental and control traps.

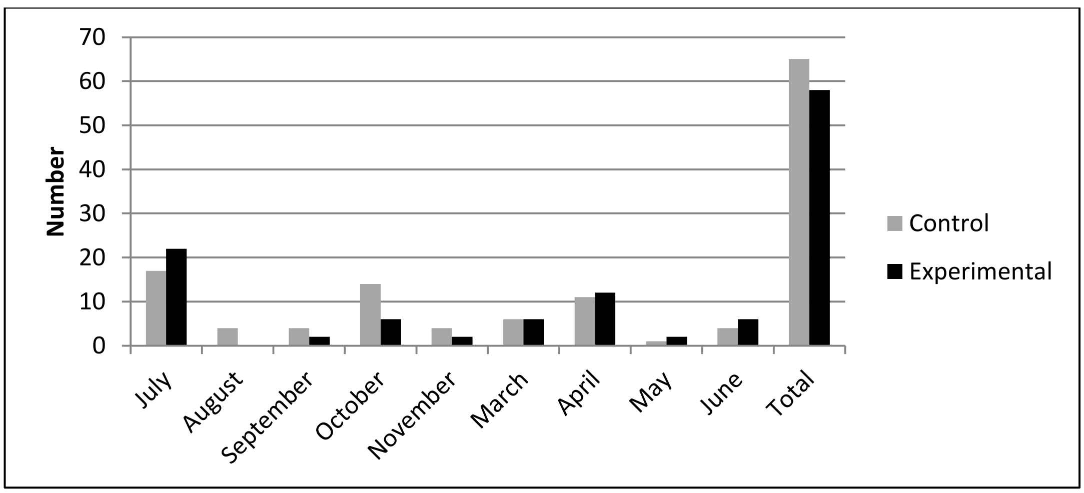

Figure 5. Monthly captures blue crabs < 127 mm in experimental and control traps.

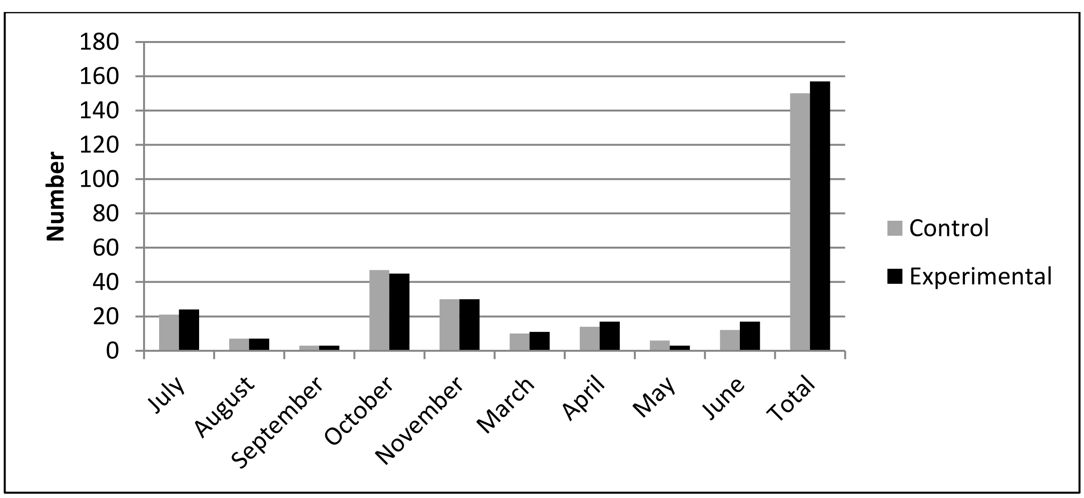

Figure 6. Monthly captures for blue crabs ≥ 127 mm in experimental and control traps.

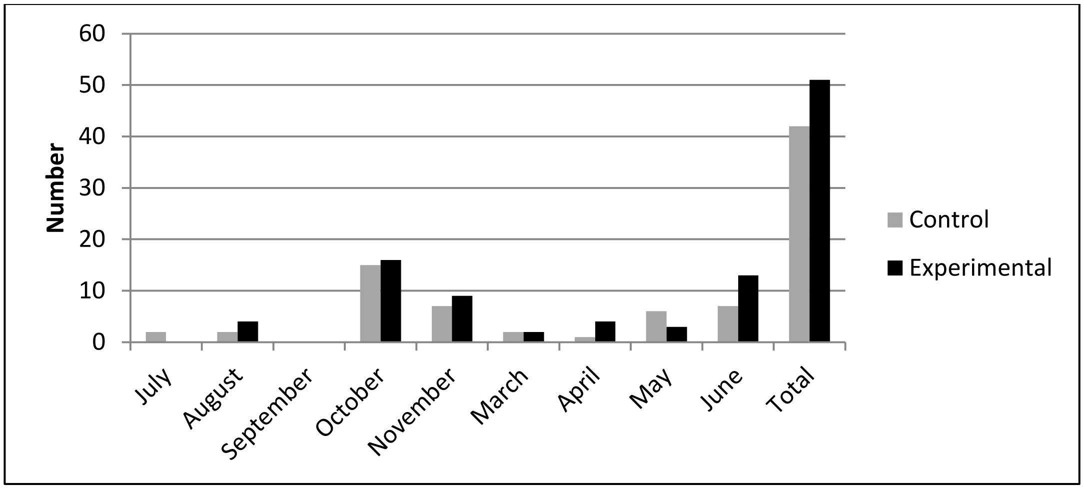

Figure 7. Monthly captures for blue crabs ≥ 152 mm in experimental and control traps.

Table 2. List of species captured in control and experimental traps.

Species	Common Name	Control (n)	Experimental (n)
Callinectes sapidus	Blue crab	215	215
Malaclemys terrapin littoralis	Texas diamondback terrapin	2	0
Lagodon rhomboides	Pinfish	3	4
Cynoscion nebulosus	Spotted seatrout	1	0
Ariopsis felis	Hardhead catfish	56	29
Opsanus beta	Gulf toadfish	0	1
Menippe adina	Gulf stone crab	4	2
Libinia dubia	Longnose spider crab	1	3
Micropogonias undulatus	Atlantic croaker	1	0
Pogonias cromis	Black drum	2	1
Atracosteus spatula	Alligator gar	1	0

Discussion and Recommendations

Texas diamondback terrapins

The first seven months of sampling were conducted in areas with documented terrapin populations within Copano Bay (Koza 2006). That only one individual was captured over seven months of sampling may suggest that sub-populations within the bay have been greatly reduced, or even extirpated. Koza (2006) calculated a CPUE of 0.37 terrapins/trap/day for Copano Bay. The CPUE for this study of 0.11 terrapins/day can be further reduced to 0.005 terrapins/trap/day in order to make comparisons with Koza's (2006) data. It is well documented that crab trap induced mortality can alter terrapin population structure (Roosenburg et al. 1997; Hoyle and Gibbons 2000; Roosenburg 2004; Dorcas et al. 2007; Grosse et al. 2009; Grosse et al. 2011). In all areas sampled during this study, there was high crab fishing pressure, and the potential effects of crab trap mortality must be considered. Because this species exhibits high site fidelity and small home range, chances of re-colonization from outside populations are low. The observed absence of terrapins in historically occupied locations suggests that conservation measures, including the requirement of BRDs on crab traps, are necessary.

Commercial crab traps are constructed of coated chicken wire and possess up to four entrance funnels. The flexibility of the chicken wire allows terrapins to stretch the opening, permitting them entrance to the trap. Once inside, terrapins are unable to surface and drown. Mortality rates as a result of drowning have been estimated at 20% to 100% depending on water temperature and time spent submerged within the trap (Wood 1997). Bycatch reduction devices exclude terrapins from traps by adding rigidity to an otherwise flexible structure. At $0.48/unit, BRDs represent an inexpensive, effective management tool for excluding diamondback terrapins from crab traps, resulting in lowered bycatch mortality in the species. Because only two terrapins were captured in this study, it is difficult to make a statement regarding their efficacy in excluding terrapins in this particular estuary, although the abundance of research demonstrating the effectiveness of BRDs suggests that they are effective in reducing terrapin mortality regardless of locale (Butler and Heinrich 2007; Powers et al. 2009; Rook et al. 2010; Coleman et al. 2011; Morris et al. 2011).

The final two months of sampling occurred in the Aransas River. While no terrapins were previously documented there, low salinities and results reported by Baxter (2013b) for the Nueces River suggested that terrapins may be found in the Aransas River as well. Baxter (2013b) reported terrapin captures approximately 10 miles up the Nueces River and speculated that this was due to higher than normal salinities in Nueces Bay. One terrapin was captured up the Aransas River in May 2014. The occurrence of terrapin several miles up the Aransas River may suggest changes in habitat use attributed to reduced freshwater inflows and the resultant high salinities in Copano Bay. At the time of sampling, Copano Bay experienced salinities above 35 PSU, while salinity for the sampled portion of the Aransas River was 25 PSU. This suggests behavioral changes in terrapins occurring in reduced inflow estuaries resulting in movements up tidal rivers in search of optimal salinities.

Ongoing drought and increasing demands of a growing human population have decreased the amount of water available to estuaries. When coastal water bodies receive inadequate freshwater inflows, hypersaline conditions may result. Estuarine organisms, such as terrapins, are not adapted to these conditions, and alterations, either physiological or behavioral, can occur. While researchers agree that crab trap bycatch mortality is the most severe threat facing terrapin populations throughout their range, reduced freshwater inflows, and the resultant hypersalinities, may pose an additional threat to populations occurring in reverse estuaries. That a terrapin was captured miles up the Aransas River in this study could further support this theory.

There are several current threats to terrapin populations in Texas. Balancing freshwater needs is a complicated issue. As populations continue to grow, increasing demands are put on a limited resource. Alleviating the threat posed to terrapins by crab traps, however, is simple. The use of BRDs in Texas provides an effective, inexpensive mean by which to reduce one stressor on terrapin populations.

Blue crabs

Overall blue crab catch was equal in both control and experimental traps. When limited to legal blue crabs (≥ 127 mm), the data show that experimental traps captured slightly more blue crabs than control traps. Experimental traps also captured more blue crabs ≥ 152 mm than control traps. These data, combined with the results from the Mann-Whitney U tests, suggest that BRDs do not negatively impact blue crab catches in number or size. In some cases, BRDs may increase the number and size of blue crabs captured as seen in this study. This is supported by results reported by Wood (1997) and Guillory and Prejean (1998).

According to state law, crab traps in Texas must have at least two escape vents (2.375", 60 mm) which allow small blue crabs and finfish to exit the trap. In this study, control traps captured more sublegal blue crabs than experimental traps. These results are similar to those reported by Baxter (2013a) in Texas, Cuevas et al. (2000) in Mississippi, and Morris et al. (2011) in Virginia. This may be attributed to the BRDs acting as an additional escape vent, allowing smaller crabs to exit the traps. This would benefit commercial crab fishermen, reducing the amount of time spent culling sublegal blue crabs. However, there is nothing to suggest that BRDs allow increased egress of legal-sized blue crabs, as evidenced by the equal numbers and sizes of blue crabs captured in both trap types. It has even been suggested that BRDs may help restrict egress of larger blue crabs, resulting in increased captures in traps equipped with BRDs (Wood 1997; Guillory and Prejean 1998).

Derelict crab traps

Crab traps are often fished in habitats shared by both blue crabs and diamondback terrapins. These actively fished traps are baited, which attracts both species. Bycatch reduction devices are useful in this scenario as they exclude terrapins while allowing blue crabs to still enter. Yet, there is another situation where BRDs may also lower terrapin bycatch mortality in crab traps. Commercial crab fishing sometimes occurs in deeper water, further from shore in areas that are not inhabited by terrapins. This greatly reduces the chances that terrapins and crab traps will intersect and may result in minimal terrapin mortality.

The issue arises when these deep water traps are lost or abandoned and become derelict. Many of these derelict traps are carried by currents, wind, and storms into shallow, nearshore habitats containing diamondback terrapins. Organisms that enter derelict crab traps are often unable to exit and die. Expired individuals then act as bait, drawing more organisms into the trap. This cycle of self-baiting, known as ghost fishing, continues until the trap degrades or is removed from the water (Von Brandt 1984). In certain situations, "ghost" traps may be responsible for higher terrapin mortality rates than actively fished traps as they are often found near shore, are never checked, and may remain in the water for years.

Currently in Texas, BRDs are not required for crab traps and voluntary use is minimal. While it is not possible to count all of the traps lost annually in Texas, estimates range from 20% - 100%, depending on several factors, including weather and vandalism. Many of these lost traps ultimately end up in areas inhabited by diamondback terrapin. A BRD requirement on crab traps in Texas would exclude terrapins from both actively fished, and derelict, crab traps, reducing the threat to terrapins in both scenarios.

Overall Bycatch

Most fisheries experience some degree of bycatch, and while it may not be possible to eliminate the capture of non-target species, efforts should be taken to minimize bycatch whenever possible. Results from this study showed lower overall bycatch in experimental traps (Table 2), and are comparable to those reported from Texas (Baxter 2013a) and from outside of the state (Wood 1997; Rook et al. 2010; Morris et al. 2011). Although specifically designed to reduce terrapin mortality, BRDs may also be effective at reducing overall bycatch, resulting in a cleaner, more efficient fishery.

Outreach

An outreach component directed at licensed crabbers was included in this project. An informational packet was sent to all licensed crabbers in the state of Texas. This amounted to 144 individuals holding a total of 178 commercial licenses. In Texas, up to three licenses may be held by one individual. The packet contained a brief description of how crab traps impact terrapins including photographs of both live, and dead, terrapins inside of crab traps. Additionally, a set of four BRDs and 16 plastic cable ties were included to encourage individuals to voluntarily equip one of their traps with BRDs. An illustrated guide to BRD installation including written instructions was also included. An example of the information included in the packets is provided in Appendix B.

In addition to the packets, a Center for Coastal Studies (CCS) researcher presented on the topic of BRDs and terrapin bycatch at a blue crab fishery enhancement meeting hosted by TPWD in Rockport, Texas. There were five such meetings held over the course of two weeks in locations along the Texas Gulf coast. The purpose of the meetings was to suggest potential regulatory changes to enhance the blue crab fishery and to evaluate the opinions of the commercial crabbers that would be affected. Included in the potential changes, was a BRD regulation for crab traps fished in Texas. Concerns regarding the use of BRDs included an exclusion of stone crabs from traps, exclusion of larger blue crabs, and increased egress of blue crabs in traps with BRDs. These concerns are individually addressed in the paragraphs below. As a whole, the commercial crab fishing community was against the use of BRDs on crab traps. After the meetings concluded, a small number of commercial crabbers agreed to voluntarily install BRDs on some of their crab traps. Volunteers were given BRDs donated by CCS at no cost to the crabbers. Photographs from the meeting are included in Appendix C.

In this study, stone crab catches were low (Table 2) and based on the limited data, it is not possible to make a statement regarding the potential exclusion of stone crabs from blue crab traps equipped with BRDs. Annual landings for stone crabs in Texas were acquired to gauge the potential economic impact if indeed stone crabs were inhibited by the use of BRDs on traps. There is no available data suggesting this, but its potential impacts must be considered. In Texas, there is no stone crab fishery, and those caught and sold are a bycatch component of the blue crab fishery. Stone crab catches are far fewer than blue crab catches, and for 2013, reported landings for stone crab claws were 9,493 lbs. representing $49,017 (Texas Parks and Wildlife Department 2013). In comparison, the annual blue crab landings for 2012 were 2,849,751 lbs. valued at $2,875,688 (Texas Parks and Wildlife Department 2012). Stone crabs in Texas represent 0.33% of the overall commercial crab landings by pound and 1.6% of the fishery's overall value. When averaged between the 144 licensed crabbers in the state, stone crab landings amount to $340/year per licensed crabber.

Concerns regarding the exclusion of larger blue crabs are unnecessary as data from numerous studies, including the current one, have shown that there is no significant difference in blue crab size between traps with and without BRDs (Cuevas et al. 2000; Roosenburg and Green 2000; Butler and Heinrich 2007; Rook et al. 2010; Morris et al. 2011). Some studies have even shown an increase in crab size in traps with BRDs (Wood 1997; Guillory and Prejean 1998). In addition to these data, a video was produced by CCS researchers showing blue crabs entering a crab trap equipped with BRDs. This video was shown at all TPWD hosted blue crab fishery enhancement meetings and can be viewed at: https://www.youtube.com/watch?v=fZCJOdJD-Ks

The concern that crab traps with BRDs will allow increased egress from traps is also unsubstantiated as evidenced by the equal numbers of blue crabs caught in both trap types in this, and numerous other, studies (Cuevas et al. 2000; Roosenburg and Green 2000; Butler and Heinrich 2007; Rook et al. 2010; Morris et al. 2011). Based on available data, traps with and without BRDs are equally effective at retaining blue crabs, and some studies have suggested that BRDs restrict egress of larger blue crabs, resulting in increased numbers in traps with BRDs (Wood 1997; Guillory and Prejean 1998).

Conclusions

There are numerous studies outside of Texas that demonstrate the effectiveness of BRDs at excluding terrapins while allowing ingress of blue crabs to traps. Managers at the state level have requested that similar studies be conducted in Texas to test the effectiveness of BRDs in Texas waters. The results of this study are similar to those reported by Baxter (2013a) for Texas and to others reported from outside of the state (Wood and Herlands 1995; Wood 1997; Guillory and Prejean 1998; Cuevas et al. 2000; Roosenburg and Green 2000; Cole and Helser 2001; Butler and Heinrich 2007; Rook et al. 2010; Coleman et al. 2011; Morris et al. 2011). There are no disadvantages, economic or environmental, to the use of BRDs, and the data provide evidence in support of the use of BRDs in Texas to reduce diamondback terrapin mortality without negatively impacting the blue crab fishery.

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Photograph A-1. Texas diamondback terrapin capture in Copano Bay, TX November 2013.

Photograph A-2. Center for Coastal Studies researcher deploying crab trap.

Photograph A-3. Typical marsh habitat sampled in Copano Bay, TX July 2013 – November 2013.

Photograph A-4. Crab trap set in Copano Bay, TX with chimney extending above water's surface.

Photograph A-5. Legal blue crabs (≥ 127 mm) captured in Copano Bay, TX

Photograph A-6. Large blue crab (≥ 152 mm) captured in Copano Bay, TX.

Photograph A-7. Blue crabs in crab trap equipped with BRDs.

Photograph A-8. Crab traps set along shoreline of a marsh in Copano Bay, TX.

Photograph A-9. Diamondback terrapin captured in the Aransas River, May 2014.

Photograph A-10. Alligator gar caught as bycatch in the Aransas River.

Appendix B – Contents of informational packet sent to all individuals holding at least one commercial crab fishing license in the state of Texas

You are receiving this informational packet because you hold at least one commercial crab license in the state of Texas. Please take a few minutes to review its contents and help us create a more efficient blue crab fishery in Texas.

All fisheries produce bycatch to some degree, and it is well known that non-target species can be negatively impacted as a result of this bycatch. For this reason, efforts have been made to reduce bycatch in a number of fisheries. The information contained within this packet offers an effective and inexpensive method for reducing bycatch in the Texas blue crab fishery.

Many non-target species are captured in blue crab traps. One of those is the diamondback terrapin. Diamondback terrapins are brackish water turtles that range from Cape Cod, Massachusetts south to Corpus Christi, Texas. Terrapins occur in coastal rivers, marshes, and bays.

Photo credit: Center for Coastal Studies, Texas A&M University-Corpus Christi

These habitats are often shared with blue crabs, which are commercially and recreationally harvested as a food source. Diamondback terrapins are attracted to baited crab traps in search of food and unbaited crab traps out of curiosity.

Photo credit: Center for Coastal Studies, Texas A&M University-Corpus Christi

Once inside, terrapins are unable to surface for air and ultimately drown. The picture below shows 96 dead terrapins removed from a single crab trap.

Photo credit: Maerz Herpetology Lab

Obviously, the conservation of dwindling terrapin populations is a priority, but there are other reasons to keep them out of crab traps. Diamondback terrapins are protected in the state of Texas and it is illegal to possess them. It has also been shown that crab traps containing terrapins catch fewer crabs.

In an effort to reduce terrapin mortality in the blue crab fishery, bycatch reduction devices (BRDs) have been developed. These devices must accomplish two things to be considered effective. First, BRDs must exclude diamondback terrapins from crab traps. Second, BRDs should not impact the numbers and size of blue crabs captured. There is plentiful evidence that both of these criteria can be met through the use of BRDs. Furthermore, a short BRD demonstration video can be seen at: https://www.youtube.com/watch?v=fZCJOdJD-Ks.

The BRDs discussed above fit inside of the entrance funnels of a crab trap, are inexpensive ($.48/each), and are easy to install. By adding rigidity to the flexible entrances, terrapins are unable to stretch the openings effectively excluding them from crab traps. These excluders are made of plastic and will often outlast the trap itself. In that case, they can be removed and reused on a new trap. A set of four BRDs (1 ¾" x 4 ¾") has been included in this packet and we encourage you to try them for yourself.

For more information on diamondback terrapins or bycatch reductions devices, please contact:

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Installing Bycatch Reduction Devices in Crab Traps

1. **One BRD (1 ¾" x 4 ¾") should be positioned on the inside of each entrance funnel towards the rear of the opening.**
2. **Heavy plastic cable ties are used to securely fasten each corner of the BRD inside each trap entrance.**
3. **Ensure that BRDs are flush and level within each entrance funnel.**

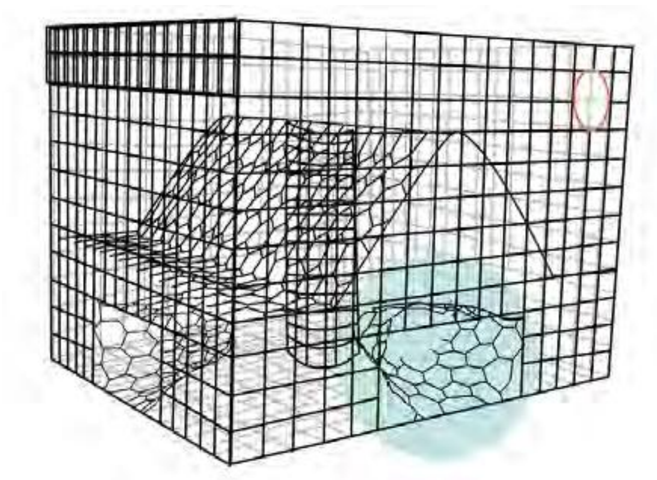

Illustration credit: National Aquarium

Additional BRDs can be purchased from TOP-ME® products:

TOP-ME® Products
5 Meadow Road
Topsham, ME 04086-5747
(207) 729-6676

Appendix C – Photographs from blue crab fishery enhancement meeting June 30, 2014 in Rockport, Texas

Photograph C-1. Art Morris of TPWD answering questions regarding BRD use in Texas.

Photograph C-2. Attendees at blue crab enhancement meeting June 30, 2014 Rockport, TX.

Photograph C-3. Volunteer crabbers holding BRDs donated by CCS.

Photograph C-4. Representatives from TPWD and commercial crab fishermen.